



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

GENETICS AND EVOLUTION IN LEPTINOTARSA

IN considering work of the kind presented by Professor Tower in his latest partial report on Evolution in *Leptinotarsa* (Tower, 1918) it is necessary, in justice to the author, that we distinguish carefully between three different things: the actual experimental work, the author's interpretation of its results, and his general speculations. Professor Tower had secured an unusually favorable opportunity for attacking his problem, by a fortunate selection of material. The "lineata" group of the genus *Leptinotarsa* comprises a large number of forms generally recognized as "good species," highly variable, crossing freely, often inhabiting markedly different environmental complexes, and easily bred in the laboratory. His work represents a prodigious amount of painstaking labor, covering many years, under most favorable conditions. It will be a matter of regret to many that so large a proportion of this volume has been devoted to very general speculation, rather than a more complete presentation of the large mass of interesting data which he has accumulated.

Considered as a contribution to genetics, there is ample confirmation, but nothing added, to what we already know, though much that was unknown at the time this work was started. The results of his extensive breeding experiments—including selection, intraspecific and interspecific crossing—show nothing, as the author clearly points out, that is not perfectly Mendelian and in accord with the factorial hypothesis. This portion of the work is valuable, at least, as added refutation to the idea that there is anything different involved in species crosses than in intraspecific crosses.

One or two of the experiments, however, give results that seem somewhat anomalous; and it is on these that the author has attempted to build far-reaching hypotheses considerably at variance with those held by other geneticists. The most striking case, perhaps, is in connection with the crosses *L. signaticollis* $\times$ *diversa* and *L. signaticollis* $\times$ *undecemlineata*. These crosses, when made with material which had been bred in the laboratory for several generations, gave normal Mendelian ratios (monohybrid in the one case, trihybrid in the other). Certain strains of *signaticollis* "fresh from nature" gave, however, in these crosses, very complex and variable arrays. Crossed with *diversa*, for example, there appeared in F_1 , besides the ordinary heterozygote, breaking up normally in F_2 , a varying number (0-100 per cent.) of forms apparently pure *signaticollis*, which bred true in all subsequent generations.

These experiments, to this point, had been previously published by the author (Tower, 1910). Further work on this apparently true-breeding race, however, has served to modify the earlier conclusions as to its composition and behavior. Careful measurements showed that this apparently pure *signaticollis* race behaved normally as regards the form-index (relation of width to length), a specific character never dissociated, in other experiments, from the conspicuous pattern difference involved. Numerous experiments with this peculiarly behaving hybrid failed, with one exception, to find any evidence of the *diversa* pattern factor present. Individuals of this race having the *diversa* (broad) form, crossed with one particular strain of *signaticollis*, gave in F_2 four homozygous forms: pure *signaticollis*, the peculiar true-breeding hybrid (*diversa* form with *signaticollis* pattern), pure *diversa*, and a new form, with a different pattern. These appeared in the ratio of 4:2:1:1 (actual numbers not given), with the corresponding array of heterozygotes.

At first sight, all this seems easy to account for: one or both of the parents in the original cross were heterozygous for one or more factors. The actual results, however, can not be accounted for, according to any known genetic principles, on the basis of the facts given. There are many things at every stage of this work, which we should like to know, about which we are told nothing. The author states that the original parents were "not heterozygous," but no evidence of any genetic analysis is given. In fact, the author declares more than once that he is not interested in ordinary Mendelian analysis, implying that it is unimportant. We do know that one, at least, of these parents was "fresh from nature," that is, genetically an unknown quantity. The author himself shows very completely, in later chapters, that these species, as found in nature, are genetically very heterogeneous. He also emphasizes that the results here obtained can probably not be repeated with material from other locations or even from the same location at other times. Again, we know nothing of the genetic constitution of the *signaticollis* strain used in the "test reaction" where typical *diversa* is recovered; except that only this particular strain will give these results. The F_2 array in this case shows that there are at least two factor-differences involved, while there is only one in the ordinary cross *L. signaticollis* $\times$ *diversa*. Other crosses, which will immediately suggest themselves as bearing on the problem, have not been made or are, at least, not mentioned.

Above all, it is to be regretted that in none of these experiments have any definite pedigrees been given, nor the methods of mating in the various stocks. The tables, moreover, are in most cases merely summaries, the original and complete data not being presented. It may well be that the full data and pedigrees of all the author's extensive experiments would be too bulky for publication; but in view of the fact that on this particular series only is based any claim of modification or addition to genetic theory, the raw data and pedigrees might profitably have been included, even to the possible exclusion of a part of the discussion.

Under these circumstances, no attempt can be made at an analysis by ordinary genetic conceptions. This whole experiment illustrates perfectly the real basis of the familiar distinction (implied also by the author in this volume) between results obtained "in the laboratory" and "in nature." The real difference, as well shown in this case, is merely one between working with known materials under controlled conditions and uncontrolled operations with unknown things.

This particular experiment has been reviewed at length, because it is, apparently, solely upon it that the author bases a large amount of rather far-fetched speculation on the "architecture of the germinal material," and the influences of the "surrounding medium" and the effects of crossing upon it. His interpretation of the results involves at least four independent, and distinctly undemonstrated, assumptions: (1) that the observed results are due, immediately, to a (reversible) change in the *relations of the genetic factors to each other*; (2) that these changes are the *direct result of the crosses*; (3) that these particular strains of *signaticollis* owe this peculiar behavior to the direct effect of (cumulative) environmental influence *on the rate of ontogeny*; and (4) that the results are profoundly and permanently modified by the environmental conditions surrounding the parents of the original cross during the maturation of the particular gametes involved.

It is needless to state that none of these hypotheses derives any support from the experience of other geneticists; the only evidence adduced by the author is that above described. The first of these hypotheses is entirely inconsistent with all that we know of the phenomena of linkage; if there is anything certain about genetic factors, it is that they do *not* change their relations to each other. The second hypothesis is evidently reminiscent of

the pre-Mendelian conception that something new is produced by the act of hybridization.

In his third hypothesis, the most characteristic and the most involved of this group, there seems to be some confusion in the mind of the author himself as to whether the environment has produced its effect directly upon the gametes, or through its modification of the rate of ontogeny. The latter, however, is clearly implied in several places. But, beyond speaking of hypothetical and rather vague "cytoplasmic determiners," he makes no attempt to even postulate a mechanism by which the *rate of ontogeny*—in this case clearly, on the evidence, a somatic modification, directly dependent on temperature and moisture—can effect genetic changes in the germ-plasm. In regard to the direct effects (immediate or cumulative) of environmental conditions upon the gametes, of which the author makes much throughout his work, it can only be said that, however inherently probable this hypothesis may be, there is no evidence for it in the present work that will be acceptable to most geneticists. For the attempts to distinguish between genetic and environmental factors are, in this case, invalidated by an entirely inadequate analysis of the former. The author assumes, throughout the work, that he is dealing with materials of known genetic constitution; but this is obviously, on his own evidence, not the case. In the absence of a more complete genetic analysis of the materials, there is no valid reason to assume that there is anything involved beyond the ordinary recombination of factors originally present.

Another anomalous result is found in the cross of *L. decemlineata* $\times$ *diversa*. These species cross with difficulty; in only 2 cases out of 200 attempts was the cross successful. In both these cases (*decemlineata* ♀ $\times$ *diversa* ♂) the F_1 beetles showed all the external characters of the mother, but the food choice and development rate of the father. This hybrid *bred true indefinitely*, showing no splitting up in F_2 or subsequent generations. This kind of "stable hybrid" is familiar to us, from pre-Mendelian literature, but has never withstood the test of rigorous Mendelian and cytological investigation. Such a result can be produced deliberately, where the gametic constitution of our materials has been thoroughly analyzed, by means of "balanced lethals." Should the present case be confirmed, and the numerous sources of error eliminated, this explanation will undoubtedly be found to cover it also. The possibilities of contamination or parthenogenesis should, however, not be overlooked in such cases.

In connection with his selection experiments, the author has unfortunately adopted the theory of "germinal variations" (*i. e.*, modifiability of the genes) since abandoned by its principal proponent. Tower's evidence, like all the other evidence for this theory, is based on a very evident confusion of biotypes with phenotypes, and an apparent failure to recognize *the vital importance of rigid brother-sister mating* in such experiments. In the same experiments, the author finds a very complete refutation (in this case, at least) of his own favorite theory of the direct influence of the environment. In contrast to these indecisive or negative results, there is at least one very beautiful and unquestionable demonstration of the effect of modifying factors (here called "genetic impurities"). Of the three methods by which he attempted to limit the range of variation in the form-index of a certain "biotype" (as he calls it) of *L. multiteniata*—namely, control of the environmental complex, ordinary selection of extremes, and selection of an obvious modifying factor—only the latter gave definite and permanent results. When certain individuals, showing a peculiar variation in pronotal pattern, were selected and bred for this character, *there was an immediate and permanent reduction of the form-index variation to less than half its former range.*

The most interesting and startling contribution made in the author's earlier report (Tower, 1906)—the production of mutations in *L. decemlineata* by temperature and humidity, combined with selection—is not again referred to in the present paper. In regard to the supposed effects of these external conditions in the present work—granting, in the absence of the details of his technique, that the author has been more successful than any other worker in the exact control of humidity and evaporation-rate, there is no evidence, which will be satisfactory to most geneticists, that these factors had anything to do with the results observed.

The results of the author's extended observations and experiments with these same materials "in nature," while generally inconclusive, like all such experiments, are in complete harmony with the general conception of the processes of evolution held by the modern adherents of the factorial hypothesis. The picture we get of the conditions in this group of organisms is one of complex genetic constitution, differing greatly in different localities, resolvable entirely into simple Mendelian factor-differences, a probable selective effect of environmental complexes, with a

direct modifying effect of temperature and moisture actually demonstrated only as regards the rate of ontogeny.

With regard to the general philosophic speculations of the author, which occupy a large portion of this volume, little need be said, as this sort of thing is largely a matter of taste. The author states very unmistakably that his viewpoint is purely mechanistic, but there is much that will scarcely be accepted as such by most mechanists. For instance, his list (p. 6) of the "Categories of Organic Characteristics"—(1) "Specific Properties or Qualities," (2) "Attributes" and (3) "Conditions"—will be regarded with suspicion by those to whom metaphysics is the *bête noir* of biology. The same may be said of his aversion to "particularistic" theories of heredity. His objections, like most other recent ones, are based on a supposed identification of the gene with a somatic "unit character." Yet he is himself guilty, to an extraordinary degree, of such a confusion in his "scheme of classification of the agents of the germ plasm" (p. 86), where his hypothetical factors are classified entirely according to their apparent somatic effects. This scheme is also dominated by the "organism as a whole" dogma—that the "basic" characteristics of the race are transmitted through the cytoplasm, only trivial characters through the chromosomes and capable of dissociation from the "species complex."

On the whole, it may be said that Professor Tower has convincingly demonstrated the truth of his fundamental premise, that "the general philosophical conceptions from which we interpret nature will largely determine the logical, philosophical, and experimental methods used in investigation and the hypotheses created."

C. R. PLUNKETT

LITERATURE

Tower, W. L.

1906. An Investigation of Evolution in Chrysomelid Beetles of the Genus *Leptinotarsa*. Carnegie Institution of Washington.
1910. The Determination of Dominance and the Modification of Behavior in Alternative (Mendelian) Inheritance by Conditions Surrounding or Incident upon the Germ Cells at Fertilization. *Biol. Bull.*, 18.
1918. The Mechanism of Evolution in *Leptinotarsa*. Carnegie Institution of Washington.